SANA

SCIENTISTS AGAINST NUCLEAR ARMS

NUCLEAR WEAPONS: THE PHYSICAL AND MEDICAL EFFECTS

Nuclear weapons are fundamentally different from conventional weapons. First, they have enormous destructive power — ranging from 1,000 tons of TNT equivalent to 20 million tons — from a single warhead. Second, whereas conventional weapons give out most of their energy in the form of blast, nuclear weapons produce, in addition, a large amount of thermal radiation (heat-flash) and ionising radiation (initial and delayed).

Third, whereas the effects of conventional weapons are short-term and localised, some effects of nuclear weapons (nuclear radiation and the fires resulting from the heat-flash) have persistent and also global consequences.

1   Initial nuclear radiation

This radiation is emitted instantly from all nuclear explosions, making up about 5 per cent of the total energy of the weapon. It consists of very fast neutrons and gamma rays (like X-rays but more penetrating). With relatively small weapons, like those exploded above Hiroshima and Nagasaki, initial nuclear radiation can be lethal or injurious at greater distances than the blast and heat. This would also be the case with the neutron bomb, which is designed to maximise its initial nuclear radiation intensity.

For the majority of strategic and medium-range and long-range nuclear weapons, initia nuclear radiation is only significant within relatively short distances. Within this range, blas and heat-flash are much more destructive: hence the initial nuclear radiation is ignored fo such weapons. The medical effects of initial nuclear radiation are similar to those produce by delayed nuclear radiation from fallout (described below).

2   Electro-Magnetic Pulse (EMP)

After a nuclear explosion near the ground, or very high up in the atmosphere, the gamm rays from the initial ionising radiation interact with the atoms of the air, producing extremely high voltage pulse known as the EMP. It is similar to lightning in nature (thou not visible) but sharper and more intense. The EMP is believed to be harmless to huma but can damage sensitive electronic devices which are used in practically all mode communication and industrial control systems. It can also cause surges on transmission li and hence widespread failures of electricity supplies. A high-altitude explosion can ca such damage over a wide area at ground level, limited only by the Earth's curvature. A o Megaton (1,000,000 tons of TNT equivalent) explosion, for example, 200 miles above Pola would cause EMP effects throughout most of Europe. It is also difficult to assess effectiveness of measures taken to protect electronic equipment against the EMP.

References

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3   Thermal radiation

For a nuclear explosion on or near the ground (i.e. when the fireball which forms immediately after the detonation touches the ground surface) 18 per cent to 35 per cent of the total weapon's energy is manifested as flash/heat. This compares with 35 per cent to 45 per cent (depending on the explosion altitude) for explosions in the air (airbursts). Thermal radiation from nuclear explosions can cause severe skin burns, eye injuries and fires at considerable distances from the centre of the explosion. Thermal radiation is emitted from the fireball and absorbed by targets within a few seconds after the detonation.

The distances at which certain degrees of skin burns and eye injuries can be caused by a specific explosion depend on weather conditions and on the time of day. The clearer it is (good visibility, no haze, fog or snow) the longer these distances are. A layer of cloud above the explosion, and/or a snow cover on the ground, will increase the intensity of the heat received at a certain point, because of reflection. In the case of a 1-Megaton airburst at 7,200 feet above the ground, with good visibility (12 miles), at distances up to 6½ miles, all exposed people will receive third degree burns (the skin is charred and burnt through its full thickness). At 7 miles, half of those exposed will have second-degree burns (partial skin-thickness burns). At 10 miles, half of those exposed will have first-degree burns (reddening of the skin, at worst equivalent to a severe sunburn). It is only beyond 14.5 miles that exposed people will escape the flash burns. Temporary flash blindness can be caused to people who are not necessarily looking directly at the fireball at more than 11 miles away on a clear day and more than 52 miles away at night. Permanent retinal burns can be caused in the eyes of persons or animals looking at the fireball at more than 31 miles away on a clear day, and up to 57 miles away at night.

For a groundburst, the corresponding distances are about 20 per cent shorter. Third-degree burns can be fatal even in ideal conditions in peace time because they require highly sophisticated nursing care, including plasma and blood transfusions. It is almost certain that all persons with third-degree burns would die in the conditions of a nuclear war. Second-degree burns are, from the point of view of the immediate surgical problems, almost as severe an injury as are full-thickness burns; although they do not require skin grafting they still require elaborate dressing and intensive care. Some sources (2) assume that even second-degree burns would be fatal in nuclear war. First-degree burns would not normally require treatment, although they can be very painful and cause dehydration.

How many people would be affected?

To give an example of the effects of just a single weapon, in a 1-Megaton groundburst on 'Spaghetti Junction' in Birmingham, around 62,000 people would suffer third-degree and second-degree burns and around 29,000 people would suffer first-degree flash burns, assuming that only 5 per cent of the population were exposed to the fireball. If there was no warning of an attack the percentage would be higher.

The intense heat from the fireball will also start fires. These fires could extend up to six miles away in the case of a 1-Megaton groundburst. Some of these fires could spread and join, ultimately resulting in a fire storm or in a conflagration. In either case, many more people would be killed and injured, especially those who were already injured by the blast and were unable to escape.

4   Blast

Once the fireball in a nuclear explosion starts to form, a blast wave travels away from it, hitting the ground, reflecting from it and then travelling along the ground outwards. The

blast wave is followed by very high speed winds (from several hundred to several tens of miles per hour), resulting in widespread damage to all types of structures. People are killed and injured because of the collapse of buildings on top of them, because they are flung against standing objects by the winds, and because they are hit by flying debris. It is convenient to describe the blast damage in rings around the centre of the explosion, termed the A, B, C and D rings. Table 1 below shows the dimensions of these rings, the wind velocity, the degree of blast damage in each ring and fatalities and casualties within them.

Table 1
Blast effects and their casualties for a 1-Megaton explosion

Ring	Distance/miles Groundburst	Airburst	Max. wind speed/mph	Damage	Average Fatalities	Average Injuries
A	0 to 1.75	0 to 2.4	330	Severe; factories destroyed	98%	2%
B	1.75 to 2.8	2.4 to 4.1	165	Severe; houses destroyed	50%	40%
C	2.8 to 4.8	4.1 to 7.5	70	Severe/moderate; roofs, walls and doors damaged	5%	45%
D	4.8 to 7.25	7.5 to 11.0	35	Moderate/light; roofs, walls and doors damaged	—	25%

If one again considers the 1-Megaton groundburst at 'Spaghetti Junction' we estimate that about 190,000 people would be killed and a further 420,000 would be injured from blast effects alone. Blast injuries would include fractures of limbs, cuts, lacerations, bruises and internal injuries. Some of the injured will have suffered flash burns beforehand, which would reduce their chances of survival.

5 Fallout radiation

In a groundburst a significant proportion of the weapon's energy is spent in forming a crater. For a 1 Megaton explosion, millions of tons of earth from the crater are sucked up into the fireball and are carried into the radioactive cloud. The largest highly radioactive particles start to fall in the vicinity of the explosion within 15 minutes to one hour after the explosion. Smaller radioactive particles are carried with the surface and low altitude winds and gradually fall at various distances downwind, constituting, together with larger particles, the local fallout. The distribution of fallout is very difficult to predict with certainty because it is very much depends on wind speed and on other weather conditions like rain. It is quite certain, however, that lethal doses of fallout could be absorbed by exposed people and animals in the first few days after the attack, over a wide area.

The fallout radiation dose actually absorbed by people will depend on the degree of protection they get from undamaged houses or purpose-built shelters. Houses moderately or severely damaged by blast and fire will provide little or no protection from fallout radiation.

The effect of radiation (initial or delayed) on an individual will depend on their age, size, general state of health, and on the nature of dose of radiation. For fallout radiation (which is mostly in the form of gamma rays), if a healthy adult population were to receive 450 rads (units of absorbed nuclear radiation) over a day or two, then half would die from the acute symptoms within the first three months after exposure. The acute symptoms include vomiting, nausea and diarrhoea. Radiation damage to bone marrow and lymphatic tissues disrupts blood-forming functions, the number of blood cells falling and rendering the body susceptible to infection and haemorrhage. It is almost impossible for doctors to distinguish between those who may die and those who may survive their radiation injuries.

Children, the aged and the sick would die from lower doses of absorbed radiation than those indicated above. People who have combined injuries that separately are not lethal will have a slim chance of surviving. Those, for example, who received moderate skin burns or blast injuries and then received sub-lethal doses of fallout radiation, would be likely to die subsequently.

Returning to the example of a 1-Megaton groundburst at 'Spaghetti Junction' and considering a south-westerly wind with a speed of 15 miles per hour, 400,000 people in the County of West Midlands alone could be affected by fallout. 275,000 of these would die, while 125,000 could survive their radiation injuries. Exposed people as far as Nottingham could accumulate a dose of 500 rads in 24 hours, half of them dying as a result.

In an airburst within minutes of a nuclear explosion in the air, a radioactive mushroom-shaped cloud, made up of the weapon's materials and dust in the air, is formed. The cloud drifts with medium- and high-altitude winds and the radioactive particles start to fall to the Earth at considerable distances downwind, forming a global fallout. Since these particles could take days or months to fall, their radioactivity would have decreased considerably, and as a result their immediate (short-term) effects would be insignificant. (See however para. 6 where more recent estimates are discussed). This global fallout would, however, have long term effects, manifested in increased occurence of cataracts, leukemia, multiple myeloma, cancers of the thyroid, breast, lung and stomach; and tumours in children exposed before birth.

6 Intermediate-timescale radioactive fallout

A recent study by R. P. Turco and others (6) shows that exposure to radioactive fallout would be more widespread and more serious than previously predicted. This is because previous estimates had overlooked intermediate-timescale washout and fallout of nuclear debris from detonations of nuclear warheads with lower yields than about 1-Megaton. This intermediate fallout would occur over a period of many weeks. In a nuclear war in which 5,000 Mt had been detonated (i.e. less than 40 per cent of the strategic and theatre nuclear weapons of the USA and the USSR) the radiation doses from such intermediate fallout would be greater than 250 rad for exposed people in about 30 per cent of the land surface of Northern mid-latitudes (30°N to 60°N), and greater than 100 rad for 50 per cent of the land area in these latitudes. These doses are about ten times greater than previous estimates. A 100 rad dose is equivalent to approximately 1,000 medical X-rays. Doses as large as this can affect the immune system and increase the probability of infectious diseases, cancer, and genetic and embryonic effects.

7 Darkness and sub-zero temperatures

A 5,000-Megaton nuclear exchange would cause extensive fires. The sooty smoke from these fires would strongly absorb sunlight in the upper atmosphere, as a result of which the amount of sunlight at ground level could be reduced within a week after the war, to only a few per cent of normal. An unbroken gloom would then persist for weeks or months over the Northern Hemisphere. Land temperatures would drop to about minus 20°C within three weeks and would remain below zero for more than three months. It would take more than